ENVIRONMENTAL RADIATION PROTECTION STANDARDS FOR YUCCA MOUNTAIN: CONSIDERATIONS ON ISSUES

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ABSTRACT

The Energy Policy Act of 1992 (EnPA) directed the Environmental Protection Agency (EPA) "to set generally applicable standards for the Yucca Mountain site...for protection of the public from releases from radioactive materials stored or disposed of in the repository at the Yucca Mountain site." It also directed EPA to contract with the National Academy of Sciences (NAS) to "conduct a study to provide [to EPA]...findings and recommendations on reasonable standards for protection of the public health and safety...."

Upon receipt of the NAS Report, the Agency immediately began preparation of the proposed standards. This included holding public meetings, establishing official dockets and an information file in Washington, DC and Nevada; and meetings with many stakeholders including Federal agencies, the State of Nevada (Governor's office and legislature), Nevada counties, and industry, environmental, and public interest groups. Comments have been compiled and are being considered as the Agency proceeds.

As a result of this process, there are several major issues which are being investigated and considered. These issues are critical group, form of the standard, level of protection, reference biosphere, negligible incremental risk, time frame, human intrusion, assurance requirements, and protection of ground water. This paper discusses some of the factors which the Agency has considered in formulating the standards for Yucca Mountain relative to these issues and updates the status of the rulemaking.

INTRODUCTION

As a result of the Energy Policy Act of 1992 (EnPA) (1), the Agency has requested and received technical recommendations from the National Academy of Sciences (NAS) regarding the establishment of environmental radiation protection standards for Yucca Mountain, Nevada (the NAS Report) (2). Since receiving those recommendations, the Environmental Protection Agency (EPA) has been preparing the standards. This preparation has included holding public meetings, establishing official dockets and an information file in Washington, DC and Nevada; and

conducting meetings with many stakeholders including Federal agencies, the State of Nevada (Governor's office and legislature), Nevada counties, and industry, environmental, and public interest groups.

This process has resulted in a number of issues which have been central in the Agency's deliberations. The major issues are critical group, form of the standard, level of protection, reference biosphere, negligible incremental risk, compliance period, human intrusion, assurance requirements, and protection of ground water. The following sections will describe many of the factors which the Agency has considered in formulating the standards. All issues have included consideration of comments received from all parties throughout the process even though all parties are not necessarily noted in all sections. Further, this is not intended to be an exhaustive listing of all factors under consideration but rather it is an attempt to discuss the general factors which have been involved in the Agency's process of addressing these issues. As of this writing, no final decisions have been made regarding these issues and, therefore, the discussions should not be interpreted to be a final decision or the Agency's final position simply because of the contents or lack thereof.

CRITICAL GROUP

The NAS recommended protecting individuals and to do so by using the critical-group approach (2). The critical-group approach involves the assessment of the dose received by the exposed population and then determining which subset of that population would be most exposed, i.e., the critical group. The individual doses received within the critical group would then be averaged in a prescribed manner and the average dose would be compared with the regulatory limit to determine compliance.

In previous Federal radiation-related standards and regulations, the critical-group approach has not been used. This is also true within EPA for any type of standard or regulation be it for radioactive or chemically hazardous pollutants. Therefore, the Agency has examined use of this concept and has discussed it in the context of its policy implications. There are other approaches which have been used, for example, protection of the most exposed individual in the general population and the adoption of an approach which has been used in regulating some chemical hazards, i.e., a reasonably maximally exposed individual.

Under the most-exposed-individual approach, a person would be a hypothetical individual who would be assumed to have characteristics and be in circumstances which would result in that individual receiving more dose than any other member of the general population. Historically, this has been the most common form of radiation standards and regulations. This approach has the advantage of protecting all individuals in a population to a set level. However, it has been criticized frequently as resulting in projected doses than would not occur in reality and, therefore, resulting in unnecessary protective measures.

The regulatory scheme used in some of EPA's chemically related regulations uses a projected individual dose which is intended to be representative of the highest of all doses

received by the general population but to allow use of less than the absolutely highest values of the parameters used to estimate doses. In other words, most of the parameters would be held to their highest values but some of them could be reduced a reasonable amount. The purpose of this approach is to arrive at a dose which would be the highest for at least 95% of the population but would not be the absolutely, highest theoretical dose, i.e, it is a dose which could reasonably be expected to be the highest in the population. This approach has the attractiveness of attempting to be cautiously realistic but could, theoretically, result in some doses being above the regulatory limit.

Another factor is the lifestyle of the group or individual. The NAS suggested two starting points (2). One was a statistically generated group which would take into account a spectrum of lifestyles, e.g., from people who eat, drink, and live only in the contaminated area to those who only live in the contaminated area but there food and water are from non-contaminated areas. The other NAS suggestion was the use of a so-called "subsistence farmer" who would only use water from the contaminated area for both domestic and farming uses and eats only food grown using contaminated water. There have also been suggestions that there are possibilities of assuming an individual or group that lives in the area and raises some of its own food and drinks from the aquifer but also "imports" food and fluids from other sources. The Agency has studied a number of possibilities within the bounds of these suggestions.

FORM OF THE STANDARD

There are two basic choices being considered as a result of the EnPA and the NAS Report, i.e., dose and risk limits (1, 2). The choices are brought about simply because in section 801 of the EnPA is the direction that EPA's standards "shall prescribe the maximum annual effective dose equivalent to individual members of the public...." while in the NAS Report is the recommendation that the standard for the protection of individuals be stated in terms of the risk of developing a fatal cancer.

A difficulty has arisen out of an inconsistency which is because of another provision in the EnPA and an action of NAS. In section 801, is a phrase which states that the EPA standards shall be "based upon and consistent with the findings and recommendations of the National Academy of Sciences...." (1) Therefore, the Agency is faced with Congressional guidance to set a standard in terms of dose and to be consistent with the recommendations of the NAS. However, the NAS has recommended setting a standard stated in terms of risk (2). Technically, dose and risk can be interchanged with approximate parity. However, these conflicting requirements have been a source of legal and policy discussion.

LEVEL OF PROTECTION

The NAS stated that the level of protection is a matter of public policy which should be reached through a public rulemaking conducted by EPA. However, the NAS recommended a starting point for their risk recommendation, 10^{-5} to 10^{-6}/yr (i.e., an annual risk of one in 100,000 to one in 1,000,000) of developing a fatal cancer (2). The Agency estimates this risk range to

correspond with an annual dose range of 200 to 20 microsieverts (μSv). The NAS pointed out that this level is consistent with existing levels which have been set by radiation regulatory authorities both inside and outside the United States (2). For example, EPA's generic standards for the disposal of spent nuclear fuel, high-level and transuranic radioactive wastes limits doses incurred by individuals to 15 μSv per year (3).

Some groups have commented that an annual dose of 1 mSv is considered to be safe by national and international authorities, including EPA. However, the Agency has proposed that dose as an acceptable level for members of the public exposed from all sources except background and medical exposures (4). The EPA, and international guidance, then requires that this overall dose be apportioned among actual and currently known potential sources and future exposures. In the vicinity of Yucca Mountain are several potential sources of exposure for a critical group, for example, the waste disposal site in Area 5 and the weapons testing areas on the Nevada Test Site, the commercial low-level radioactive waste disposal site near Beatty, Nevada, and a potential interim storage site for spent nuclear fuel.

REFERENCE BIOSPHERE

In the preamble to 40 CFR Part 191 (3), the Agency stated that, on a generic basis, it considered it more important to center analyses of a disposal system's performance on factors such as geology, hydrology, and general climate change. The nearly infinite ways in which people, technology, and society could change over very long periods lead to such speculative gambits that it is not possible to reasonably model those changes. The NAS stated that there was no scientific basis for estimating such changes and suggested using a fixed, or reference, biosphere (2). However, the Agency is also aware that other countries have examined a number of possible future biospheres which are then postulated in considering future performance of a disposal system.

NEGLIGIBLE INCREMENTAL RISK

The NAS adapted the National Council on Radiation Protection's (NCRP) concept of "negligible incremental dose" to their suggestion of using a risk-type limit to arrive at the concept of "negligible incremental risk." The NAS stated, "The negligible individual dose is defined as a level of effective dose that can, for radiation protection purposes, be dismissed from consideration." (2) The public comment period brought strong reaction from most commenters who were not in favor of this being used for the Yucca Mountain standards.

Much of the reason that such a concept arises is that there is debate in the scientific community about how much small increments of radiation exposure above the natural background can change the risk of causing adverse effects in people. The current position of the Agency is that it is prudent to assume that any amount of radiation carries a risk of causing an effect. The word "prudent" is used since there is no direct, epidemiological data which can conclusively show what, if any, effect there is at low doses, i.e., at levels similar to background doses and dose rates but in addition to background exposures. It is possible that there is a level below which no

effects occur or there could be greater than a linearly proportionate effect occurs since the current estimates are based upon extrapolation of effects seen at much higher doses. That is why EPA has, in the past, assumed a linearly proportionate risk from any size of radiation exposure. The Agency is examining the NAS recommendation, the public reaction, and its previous position in determining its proposed position for this issue relative to this rulemaking.

COMPLIANCE PERIOD

The compliance period is the time set forth in the standards for which performance of the disposal system must meet the standards. The recommendation from the NAS has caused much discussion both within and outside the Agency. The NAS found no scientific basis, based upon geology, that the time frame needed to be less than the period during which the geology would be stable in and around the Yucca Mountain site; the finding was that such stability is on the order of one million years (2).

With the exception of standards in which no compliance period is stipulated, this is by far the longest compliance period which has been suggested in the United States for the disposal of radioactive waste. In 1985, the Agency stipulated that the generic compliance period be 10,000 years which was criticized in most quarters as being too long (2). Since that time, this period has become generally accepted in similar programs where long-term performance is a concern. Of course, there was also concern that 10,000 years was not long enough since the waste would still be "hazardous." On the other hand, some chemical waste disposal regulations specify periods as short as 30 years. Therefore, the Agency is faced with a spectrum of potential compliance periods. A central concern has been the capability of current science and technology to be able to project performance within uncertainty bounds which will result in meaningful estimates for decisionmakers. Thus, the Agency is examining such capabilities and the inherent uncertainties in reaching what it considers to be an appropriate compliance period.

HUMAN INTRUSION

The NAS recommended that human intrusion not be included in the same performance standard in which all other types of disruption to the repository are analyzed (2). In its generic 40 CFR Part 191 standards, human intrusion was included in its probabilistic risk assessment (3). The NAS believed that there was no scientific justification to hypothesize human behavior by trying to project how many and what type of intrusion would or could occur during the performance period. Rather, the NAS suggested that, for Yucca Mountain, the Agency assume that a drilling-type intrusion will occur and to specify the scenario under which it occurs. Further, no effects should be calculated to the drillers or to the public as a result of waste brought to the surface (2). In the past, EPA has not attempted to protect the drillers because the Agency believes that the purpose of deep geologic disposal is to contain the waste in a limited area for as long as reasonably possible (3). To assume otherwise, would invoke an impossible situation where containment and dispersion of the waste were simultaneous goals.

ASSURANCE REQUIREMENTS

In addition to quantitative limits, the Agency has considered including several qualitative principles called assurance requirements. Such requirements would be intended to compensate for the uncertainties inherent in projecting the effects of releases from radioactive waste over long periods and, therefore, to add confidence that the disposal system would be able to achieve the level of protection established in the quantitative standards. Assurance requirements were included in 40 CFR Part 191. They dealt with use of active and passive institutional controls, monitoring, use of multiple barriers, the ability to locate and remove the waste after it is disposed, and consideration of the presence of natural resources (3). In discussing the need for such requirements for Yucca Mountain, the Agency has considered whether there are site-specific conditions which would make them unnecessary or if those conditions might require the use of assurance requirements that are considerably different than the generic requirements. The NAS recognized the need for protection beyond that inherent in the disposal system when it addressed institutional controls in its report and the public generally supported the use of such requirements (2). However, another consideration is that the increase of protection, or benefits, brought by assurance requirements cannot be precisely quantified.

PROTECTION OF GROUND WATER

In its report, the NAS recognized that 40 CFR part 191 addressed ground-water protection separately from individual-dose protection even though both use an individual-dose limit (3). Also, the NAS identified the ground-water pathway as an important pathway for defining who was to be protected by an individual-protection standard (3). However, the NAS provided no recommendation for including or excluding separate ground-water protection requirements

Ground water is a valuable resource with many potential uses. In 40 CFR Part 191, the ground-water protection standards protected ground water that is used as drinking water by restricting contamination to the maximum contaminant levels (MCLs) which have been established under the authority of the Safe Drinking Water Act. In addition to drinking, ground water may be a source of radiation exposure when used for irrigation, stock watering, food preparation, showering, or when incorporated into various industrial processes. In addition, ground-water contamination is of concern to EPA because of potential adverse impacts upon ecosystems, particularly sensitive or endangered ecosystems.

However, the primary purpose of such standards is to prevent contamination of drinking-water resources. This prevents the need to decontaminate that water in the future which, if not done, would place the burden on future generations to implement expensive clean-up or treatment procedures. Therefore, it is prudent to protect drinking water from contamination through prevention rather than rely upon treatment. Another possibility is that the disposal system itself could become subject to clean-up by future generations.

STATUS OF THE RULEMAKING

The Agency is evaluating and discussing issues. Efforts are continuing to gather and analyze information on the disposal system and the environment outside the Yucca Mountain site. The proposed standards will be sent to the Office of Management and Budget (OMB) for review prior to proposal. Following release from OMB, there will be a public-comment period and hearings. It is planned to propose the standards in mid-1998. Final standards and support documents will be issued as soon as possible thereafter.

REFERENCES

1. *Energy Policy Act of 1992*, Public Law 102-486, 106 Stat. 2921.
2. *Technical Bases for Yucca Mountain Standards*, National Research Council, National Academy Press, Washington, DC, 1995.
3. Part 191 of Title 40 of the Code of Federal Regulations, *Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Waste*.
4. Proposed *Federal Radiation Protection Guidance for Exposure of the General Public*, Federal Register, Vol. 59, No. 246, December 23, 1994.